Field Report for Airborne Data Collected
In Support of US EPA Region 6
South 4 Group Fire
03 December 2019

Background

On 27 November 2019 an explosion and subsequent fire was reported at the South 4 Group facility located near Port Neches, TX. Local information indicated that at approximately 0100 (central) a large explosion rocked the area. The explosion subsequently caused a massive fire at the facility in a short amount of time. Local officials ordered an initial evacuation of 0.5 miles on 27 November 2019 which was extended to 4 miles around 1430 (central). The evacuation order was lifted at 1000 (central) on 29 November 2019. Reported onsite products include various olefins, butadiene, and isobutylene. The geographical coordinates of the facility are 29.9222N, 95.0547W (figure 1).

The US EPA Region 6 requested that the ASPECT system be deployed to provide monitoring support beginning on 27 November 2019. This report summarizes findings observed during the two missions flown on 03 December 2019.

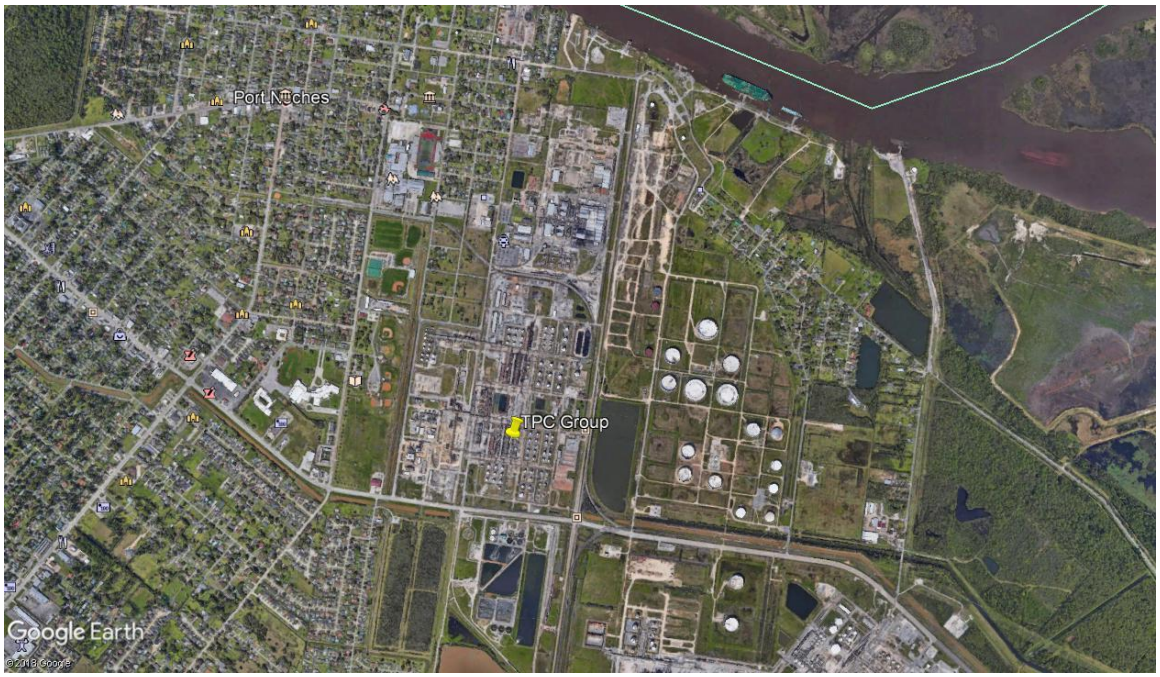

Figure 1: South 4 Group Facility, Port Neches, TX

ASPECT response to this Mission/Incident was in support of:
US EPA Region 6. OSC: Adam Adams

On 27 November 2019 ASPECT was dispatched to collect aerial remote sensing data over the South 4 Group facility located near Port Neches, TX and conducted three data collection missions. An explosion and fire involving a production unit and subsequent tank farms resulted in a black plume moving toward the south. Reports from the air crew indicated that significant lofting was occurring with smoke reaching 4000 feet above ground. Collected spectral data from both the IRLS and FTIR did not show any chemical detections. Data analysis from the second and third mission showed consistency to that of the first with the presence of a large thermal signature with the absence of detected compounds.

Due to poor weather and very low ceilings, ASPECT was only able to collect a few oblique images on 28 November 2019 and did not fly at all due to poor weather on 29 November 2019. On 30 November 2019 ASPECT collected aerial remote sensing data over the South 4 Group facility located near Port Neches, TX. Analysis of FTIR data did not show any chemical detections. IR image analysis showed the presence of elevated temperatures within the reactor complex, but the magnitude was substantially reduced from prior missions. Visible imagery showed only a light grey plume being generated at the facility with no active fires immediately visible. Damage to the facility and nearby spherical tanks was clear in the aerial and obliques images.

ASPECT conducted two flights on 01 December 2019. Analysis of IR imagery collected during the morning flight on 01 December 2019 indicated that isolated elevated thermal locations still exist within the production unit. Visible imagery confirmed that crew reports of light gray smoke was being emitted from the facility and was moving in an easterly direction. FTIR data collected in the vicinity of the facility showed one detection of isobutylene near the Orchard Ave bridge. The estimated concentration was about 1 ppm. Analysis of IR imagery of the junction of the waterway east of the facility which intersects with the Naches River showed no evidence of oil sheen. The afternoon showed a low thermal environment within the process unit and minimal smoke being emitted from the site. The analysis of imagery showed that four water cannons were being employed at the facility. IR imagery did not show any oil sheen presence on the Neches River. Analysis of FTIR data showed detections of isobutylene south of the facility near the wastewater treatment plant. These detections were approximately 1.7 ppm on two separate passes.

Analysis of IR imagery collected during the morning flight on 02 December 2019 indicated that very little thermal content was present in the process unit other than one fire on the north side of the unit. Visible imagery showed one water cannon in operation and light gray smoke being emitted from the facility due to the one fire. There were no chemical detections in the proximity of the facility. Analysis IR imagery of the junction of the waterway east of the facility which intersects with the Naches River showed no evidence of oil sheen. Flight 11 conducted on the afternoon of 02 December 2019 showed one fire on the northern edge of the process unit. A light gray smoke plume was still being emitted and at the time of the flight moving toward the southeast. Several of the reactor towers tended to show elevated temperatures as compared to the surrounding unit. IR imagery did not show any oil sheen presence on the Neches River but did

suggest that water flow is going into the river. Analysis of FTIR data showed detections of isobutylene south of the facility near the wastewater treatment plant. These detections were approximately 1.57 ppm on two separate passes.

As part of the continuing South 4 Group fire response, ASPECT was requested by Region 6 to conduct a data collection flights downwind, upwind, up the wind axis in reference to the facility and the Neches River on the morning of 03 December 2019. An afternoon flight focused on collecting data up and downwind of the facility. This report details results and information from those missions.

ASPECT System

The US EPA ASPECT system collects airborne infrared (IR) images and chemical screening data from a safe distance over the site (about 3,000 ft AGL). The system consists of an airborne high-speed Fourier transform infrared spectrometer (FTIR) coupled with a wide-area IR line scanner (IRLS). The ASPECT IR systems can detect compounds in both the 8 to 12-micron (800 to 1200 cm-1) and 3 to 5 micron (2000 to 3200 cm-1) regions. The 8 to 12-micron region is typically known as the atmospheric window region since the band is reasonably void of water and carbon dioxide influence. Spectrally, this region is used to detect carbon - non-carbon bonded compounds. The 3 to 5-micron region is also free of water and carbon dioxide but typically does not have enough energy for use. This band does show use in high-energy environments such as fires. The carbon - hydrogen stretch is very common in this region.

A digital Nikon DX2 camera (12.4 mega pixel CMOS 3:5 aspect ratio, 28 mm wide-angle lens) collects visible aerial imagery as part of the core data product package. The camera timing system is connected to the primary IR sensors and provides concurrent image collection when other sensors are triggered. All imagery is geo-rectified using both aircraft attitude correction (pitch, yaw, and roll) and GPS positional information. Imagery can be processed while in flight or approximately 600 frames per hour can be processed once the data are downloaded from the aircraft.

An Imperx mapping camera (29 mega pixels; mapping focal plane array) provides a similar aspect ratio and aerial coverage. Like the Nikon DX2, it is connected to the primary IR sensors and provides concurrent image collection when other sensors are triggered. These images are often digitally processed in lower resolution, so they can be transmitted via satellite communication. The high-resolution images (>20 MB each) are pulled from the ASPECT after the sortie and are available later.

All high resolution digital aerial photographic images collected by the ASPECT system are ortho-rectified and geospatially validated by the reach back team. In general, this consists of conducting geo-registration using a Digital Elevation Model (DEM) which promotes superior pixel computation and lessens topographic

distortion. The image is then check by a team member (using a Google Earth base map) for proper location and rotation

Data is processed using automated algorithms onboard the aircraft with preliminary results being sent using a satellite system to the ASPECT reach back team for QA/QC analysis. Upon landing preliminary data results are examined and validated by the reach back team.

Flight Results for Flight 12, 03 December 2019

Weather Conditions and Crew Report

Weather for the morning mission are given in table 1.

Table 1. South 4 Group Mission Weather

Parameter	Surface (0700)	Surface (0800)	Surface (0900)
Wind direction	325 degrees	135 degrees	135 degrees
Wind speed	2.2 m/s (5 mph)	1.3 m/s (3 mph)	2.2 m/s (5 mph)
Temperature	5.5ºC	8.3ºC	12.7ºC
Humidity	89%	90%	77%
Dew Point	3.8ºC	6.7ºC	8.9ºC
Pressure	1020 mb	1019 mb	1019
Ceiling	Clear	Clear	Clear

The crew reported that winds at altitude (2800 ft) were at about 20 kts (10.3 m/s) from the northwest (278 degrees). There was no visible plume leaving the site. At the beginning of the flight, there was one fire cannon which was increased to 4 cannons at the end.

Flight Status

The order to launch flight 12 was given at 0700 central on 3 December 2019 with the aircraft reporting wheels up at 0722. The initial data collection run over the site was at 0752 (central) The aircraft made a total of 8 data collection passes; flight information is summarized in Appendix Flight #12 and Figure 2.

Data Results

General Data Quality Objective

The following general data quality objectives are employed in conducting emergency response data collection with ASPECT:

1. To support overall situational analysis of the incident including aerial photography and IR imagery
2. To screen the incident for the presence of selected chemicals
3. To estimate the location and concentration of plumes being generated by the incident.

Figure 2: Data collection passes, Flight 12, South 4 Group Fire, Port Neches, TX. The blue lines represent the ASPECT flight path, green lines represent when the FTIR was actively collecting data, the yellow icons with star is the centroid of the line scanner image, and the camera icons represent when a photo was taken.

Line Scanner Data Results

A total of 2 test and 7 data collection passes were made in the proximity of the fire and an infrared line scanner image was generated for each pass. Figure 3 shows a typical 3-band infrared image obtained from data collected for Run 3. The thermal environment of the unit is low. At the time of the IR collection, no water cannon or emissions can be seen in the image. Figure 4 shows a close-up thermal analysis of the production facility again showing a flat thermal environment in the unit.

As part of the flight mission, ASPECT was flown along a waterway leading from the east side of the facility to the Naches River. Figure 5 show an IR image of the waterway flowing into the River. No sheen can be seen in the image.

FTIR Data Results

FTIR Spectral data at a resolution of 16 wavenumbers was collected for each pass. ASPECT uses an automated detection algorithm to permit compounds to be analyzed while the aircraft is in flight. 72 compounds are included in this algorithm and the list is given in Table 2. In addition, collected data are also manually analyzed by comparing any detected spectral signatures to a collection of published library spectra.

There were no chemical detections on the morning mission. A summary of data of the data collection is given in table 3.

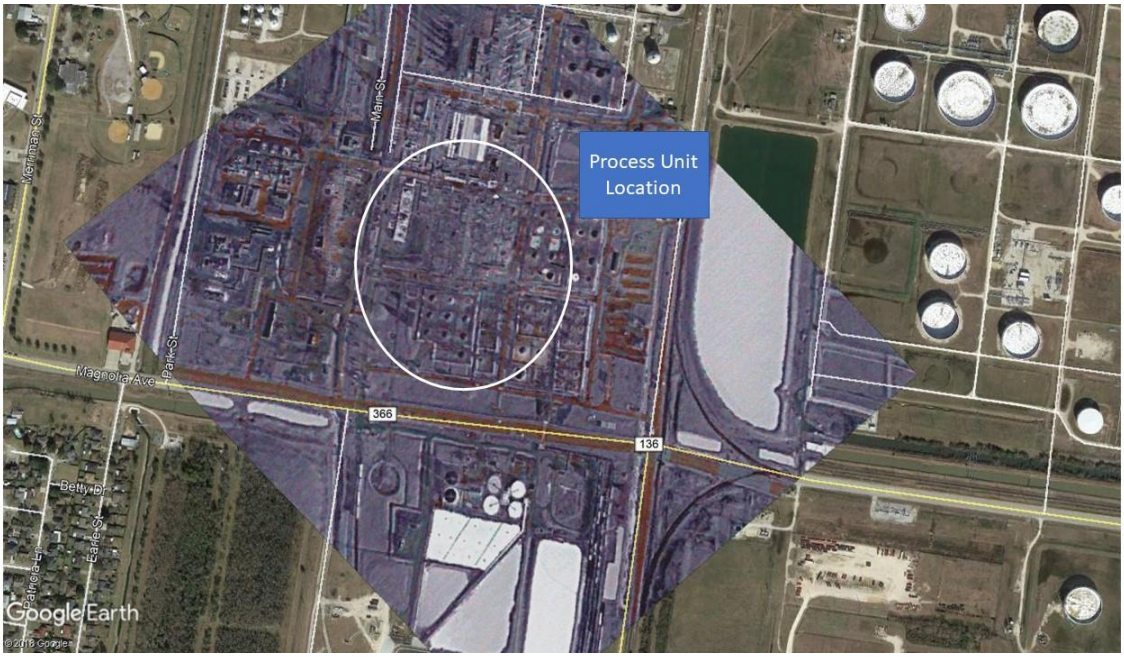

Figure 3: – 3 band IR image, Flight 12, Run 8, South 4 Group Fire

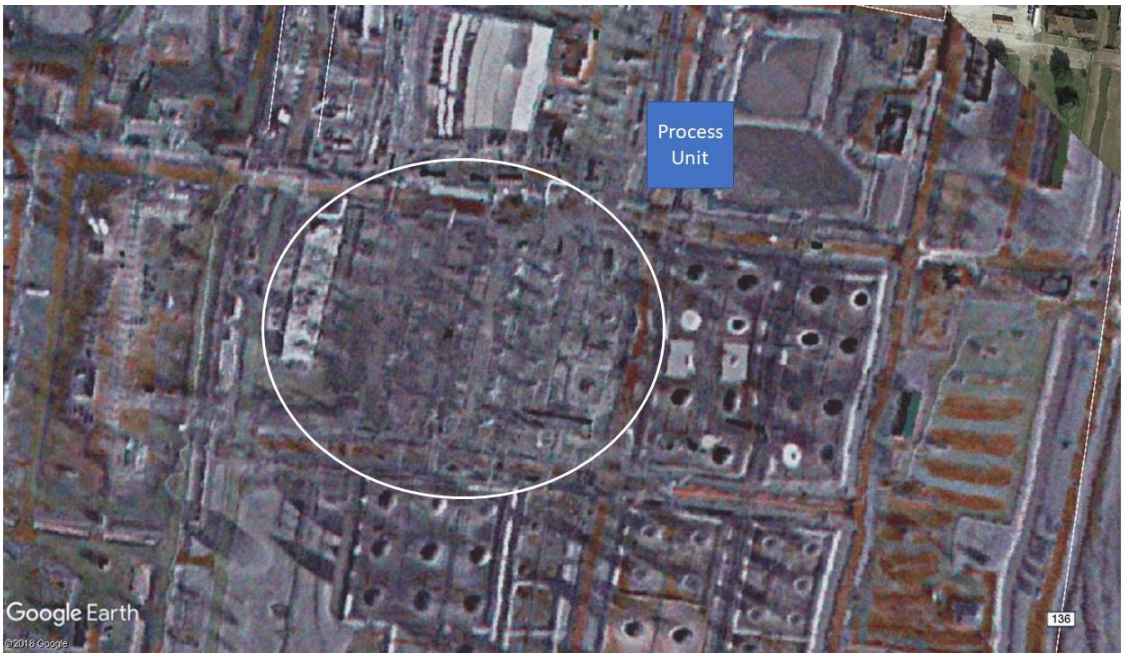

Figure 4: -- 3 band IR Image, Flight 12, Run 6, South 4 Group Thermal Image

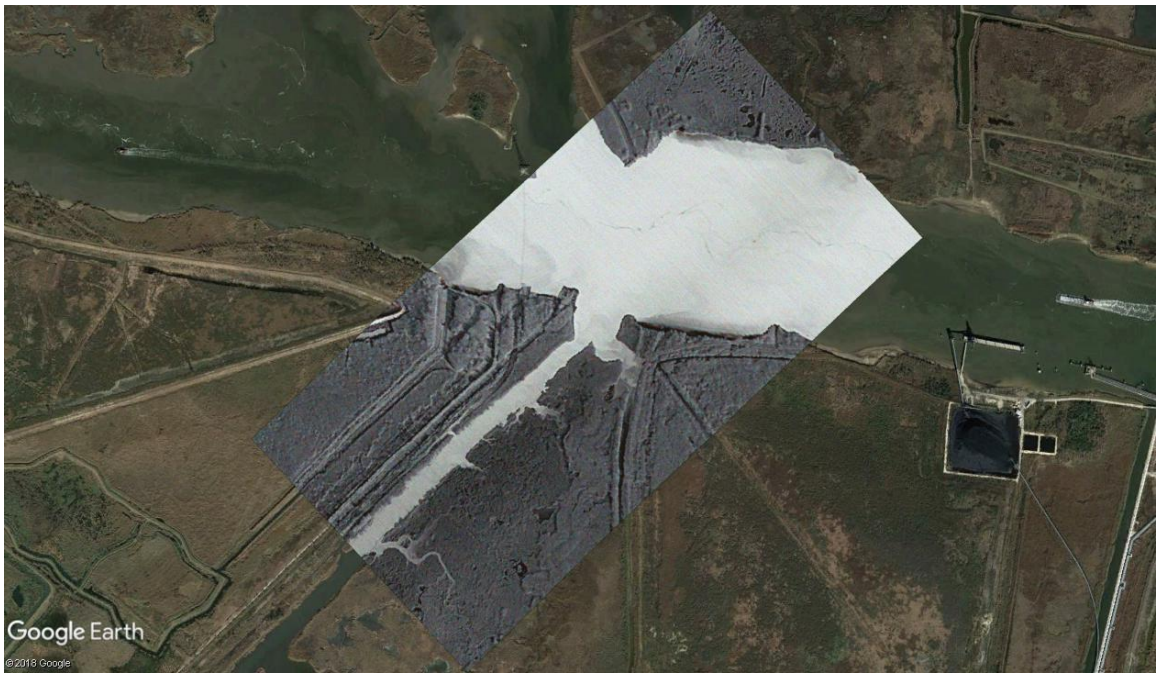

Figure 5: -- 3 band IR Image, Flight 12, Run 10, Waterway Image, South 4 Group Fire

TABLE 2 - Chemicals Included in the ASPECT Auto-Processing Library

Acetic Acid	Cumene	Isoprene	Propylene
Acetone	Diborane	Isopropanol	Propylene Oxide
Acrolein	1,1-Dichloroethene	Isopropyl Acetate	Silicon Tetrafluoride
Acrylonitrile	Dichloromethane	MAPP	Sulfur Dioxide

Acrylic Acid	Dichlorodifluoromethane	Methyl Acetate	Sulfur Hexafluoride
Allyl Alcohol	Difluoroethane	Methyl Ethyl Ketone	Sulfur Mustard
Ammonia	Difluoromethane	Methanol	Nitrogen Mustard
Arsine	Ethanol	Methylbromide	Phosgene
Bis-Chloroethyl Ether	Ethyl Acetate	Methylene Chloride	Phosphine
Boron Tribromide	Ethyl Formate	Methyl Methacrylate	Tetrachloroethylene
Boron Triflouride	Ethylene	MTEB	1,1,1-Trichloroethane
1,3-Butadiene	Formic Acid	Naphthalene	Trichloroethylene
1-Butene	Freon 134a	n-Butyl Acetate	Trichloromethane
2-Butene	GA (Tabun)	n-Butyl Alcohol	Triethylamine
Carbon Tetrachloride	GB (Sarin)	Nitric Acid	Triethylphosphate
Carbonyl Chloride	Germane	Nitrogen Trifluoride	Trimethylamine
Carbon Tetraflouride	Hexafluoroacetone	Phosphorus Oxychloride	Trimethyl Phosphite
Chlorodifluoromethane	Isobutylene	Propyl Acetate	Vinyl Acetate

Table 3. Chemical Results Summary

Run	Date	Time (UTC)	Chemical	Max Concentration ppm
1	03 Dec 2019	1336	Test	Test
2		1338	Test	Test
3		1352	ND	None
4		1355	ND	None
5		1359	ND	None
6		1404	ND	None
7		1408	ND	None
8		1414	ND	None
9		1418	ND	None
Note: ND = No Detections				

Aerial Photography Results

A full set of high resolution aerial digital photography were collected as part of the flight. Figure 6 shows a representative image collected as part of each pass. Smoke is not evident in the image and only one water cannon can be observed being directed into the north part of the unit. No fire was observed. The oblique image in Figure 7 shows that 5 water cannons were in operation with no evidence of fire or smoke generation.

Conclusions – Flight 12

Analysis of IR imagery collected during the morning flight on 03 December 2019 indicated showed no high temperature locations suggesting that no fire was present in the process unit. Overhead visible imagery showed at the time of collection one cannon directed on the northern portion of the unit. Oblique imagery showed 5 cannons being used over a large portion of the facility. No smoke was observed by either the crew or

analysis of imagery. There were no chemical detections in the proximity of the facility. Analysis IR imagery of the junction of the waterway east of the facility which intersects with the Naches River showed on evidence of oil sheen.

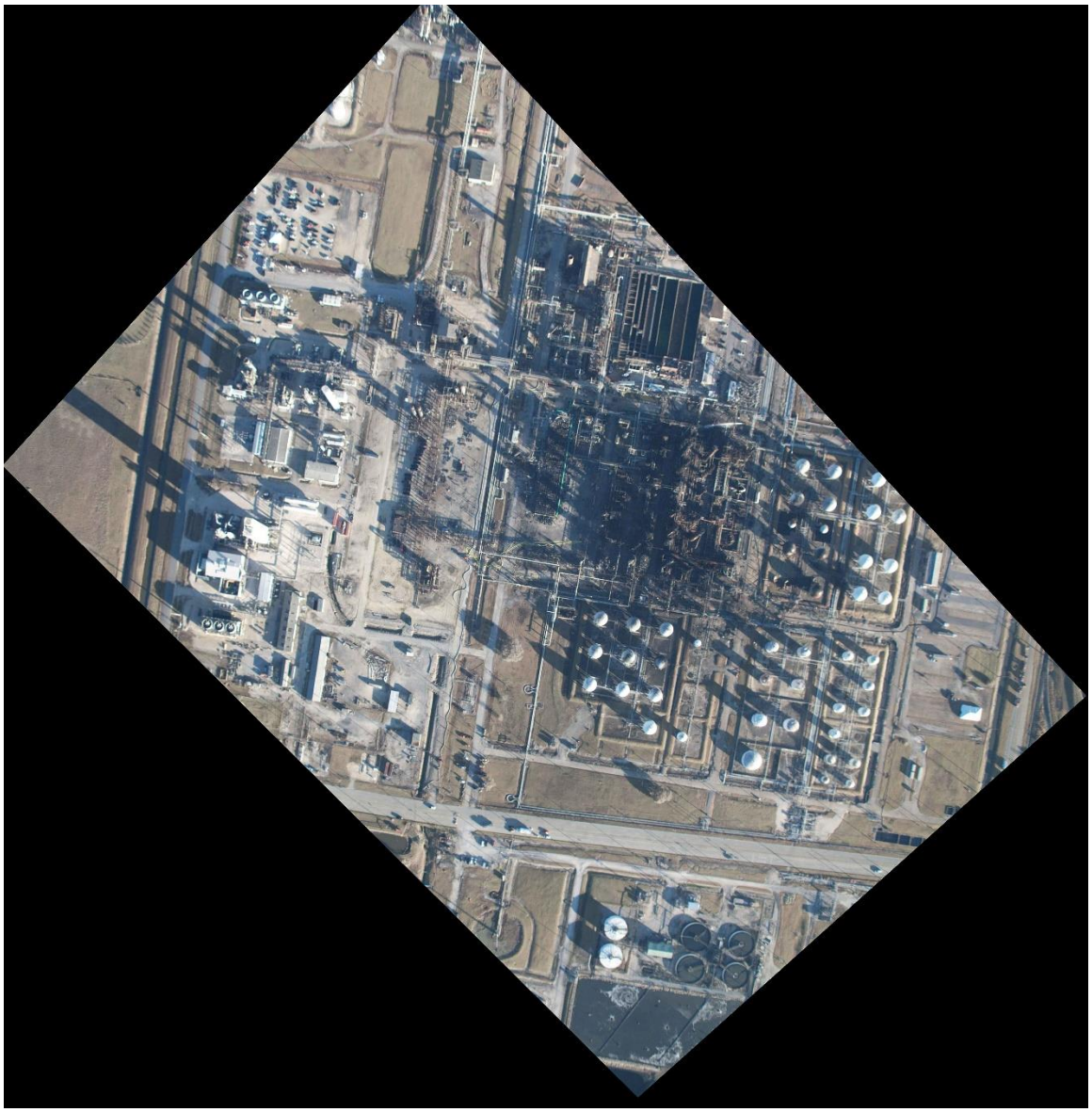

Figure 6: Aerial Image, Flight 10, Run 3, South 4 Group Fire.

Figure 7: Oblique Image of the South 4 Group Fire

Appendix Flight #12

Abbreviations:

DEM – Digital elevation model
Alt – Altitude (in feet)
MSL – Mean sea level altitude (in feet)
Digital – Digital photography file from the Nikon D2X camera
MSIC – Digital photography file from the Imperx mapping camera
FTIR – Spectral IR data collected with a Fourier Transform Infrared Spectrometer
IRLS – Infrared Line Scanner
Jpg – JPEG image format
UTC – Universal Time Coordinated
img – Spectral data format based on Grams format

Mission: 2019-12-03 South 4 Group Fire

Date: 12/3/2019
Time UTC: 13:29

Aircraft Number: N9738B
Pilot: Todd Seale
Copilot: James Glaviano
Operator: James Crisp
Aft Operator: Gerry Broyles
Ground Controller: Ahmed Hafez

DEM: Using elevation from DEM Database

Run: 1 Time: 13:36:04 UTC
  Alt: 2737 ft MSL Elev: -2 ft Elevation from DEM Database
  Vel: 140 knots Heading: 280

Digitals: None
MSIC: 3
  20191203133610159.jpg
  20191203133616508.jpg
  20191203133622857.jpg
FTIR: 1
  20191203_133609_A.igm
IRLS: 1
  2019_12_03_13_36_09_R_01 TA=2.1;TB=21.9;Gain=3
Gamma Runs: None

Run: 2 Time: 13:38:03 UTC
  Alt: 2727 ft MSL Elev: 6 ft Elevation from DEM Database
  Vel: 142 knots Heading: 291

Digitals: None
MSIC: 3
  20191203133809080.jpg
  20191203133815445.jpg
  20191203133821794.jpg
FTIR: 1
  20191203_133805_A.igm
IRLS: 1
  2019_12_03_13_38_08_R_02 TA=-1.1;TB=17.7;Gain=3
Gamma Runs: None

Run: 3 Time: 13:52:23 UTC
  Alt: 2705 ft MSL Elev: 8 ft Elevation from DEM Database
  Vel: 111 knots Heading: 139

Digitals: None

```
MSIC: 4
        20191203135229748.jpg
        20191203135236113.jpg
        20191203135242462.jpg
        20191203135248827.jpg
FTIR: 1
        20191203_135227_A.igm
IRLS: 1
        2019_12_03_13_52_28_R_03 TA=-3.2;TB=16.8;Gain=3
Gamma Runs:  None

-----------------------------------------------------------------

Run: 4 Time: 13:55:54 UTC
        Alt: 2780 ft MSL  Elev: 7 ft  Elevation from DEM Database
        Vel: 114 knots  Heading: 310

Digitals:  None
MSIC: 4
        20191203135600390.jpg
        20191203135606739.jpg
        20191203135613088.jpg
        20191203135620357.jpg
FTIR: 1
        20191203_135557_A.igm
IRLS: 1
        2019_12_03_13_55_59_R_04 TA=-3.3;TB=16.7;Gain=3
Gamma Runs:  None

-----------------------------------------------------------------

Run: 5 Time: 13:59:28 UTC
        Alt: 2748 ft MSL  Elev: 6 ft  Elevation from DEM Database
        Vel: 110 knots  Heading: 135

Digitals:  None
MSIC: 4
        20191203135934650.jpg
        20191203135940999.jpg
        20191203135947364.jpg
        20191203135953713.jpg
FTIR: 1
        20191203_135931_A.igm
IRLS: 1
        2019_12_03_13_59_33_R_05 TA=-3.2;TB=16.5;Gain=3
Gamma Runs:  None

-----------------------------------------------------------------

Run: 6 Time: 14:04:06 UTC
        Alt: 2686 ft MSL  Elev: 7 ft  Elevation from DEM Database
        Vel: 111 knots  Heading: 40

Digitals:  None
```

```
MSIC: 5
        20191203140412464.jpg
        20191203140419718.jpg
        20191203140426082.jpg
        20191203140432431.jpg
        20191203140435161.jpg
FTIR: 1
        20191203_140411_A.igm
IRLS: 1
        2019_12_03_14_04_12_R_06 TA=-2.7;TB=16.2;Gain=3
Gamma Runs:  None

-----------------------------------------------------------------

Run: 7 Time: 14:08:36 UTC
        Alt: 2713 ft MSL  Elev: 9 ft  Elevation from DEM Database
        Vel: 119 knots  Heading: 137

Digitals:  None
MSIC: 3
        20191203140842105.jpg
        20191203140848454.jpg
        20191203140854818.jpg
FTIR: 1
        20191203_140839_A.igm
IRLS: 1
        2019_12_03_14_08_41_R_07 TA=-2.4;TB=16.5;Gain=3
Gamma Runs:  None

-----------------------------------------------------------------

Run: 8 Time: 14:14:06 UTC
        Alt: 2734 ft MSL  Elev: 9 ft  Elevation from DEM Database
        Vel: 106 knots  Heading: 100

Digitals:  None
MSIC: 5
        20191203141412569.jpg
        20191203141419838.jpg
        20191203141426187.jpg
        20191203141432552.jpg
        20191203141438901.jpg
FTIR: 1
        20191203_141410_A.igm
IRLS: 1
        2019_12_03_14_14_12_R_08 TA=-2.0;TB=17.1;Gain=3
Gamma Runs:  None

-----------------------------------------------------------------

Run: 9 Time: 14:18:31 UTC
        Alt: 2721 ft MSL  Elev: 0 ft  Elevation from DEM Database
        Vel: 105 knots  Heading: 45
```

```
Digitals:  None
MSIC: 7
        20191203141837670.jpg
        20191203141844939.jpg
        20191203141851288.jpg
        20191203141857653.jpg
        20191203141904002.jpg
        20191203141910367.jpg
        20191203141912176.jpg
FTIR: 1
        20191203_141835_A.igm
IRLS: 1
        2019_12_03_14_18_37_R_09 TA=-1.8;TB=17.9;Gain=3
Gamma Runs:  None
```

Flight Results for Flight 13, 03 December 2019

Weather Conditions and Crew Report

Weather for the mission is given in table 4.

Table 4. South 4 Group Mission Weather

Parameter	Surface (1500)	Surface (1600)
Wind direction	180 degrees	180 degrees
Wind speed	4.9 m/s (11 mph)	4.5 m/s (7 mph)
Temperature	19.4ºC	19.4ºC
Humidity	52%	55%
Dew Point	9.4ºC	10ºC
Pressure	1015 mb	1014
Ceiling	Clear	Clear

The crew reported that winds at altitude (2500 ft) were at about 17 kts (8.7 m/s) from the 260 degrees. No smoke was reported being generated by the site with a total of three cannon in use.

Flight Status

The aircraft was airborne at 1443 (central) was over the site at 1439 (central). A total of 1 test and 6 data collection passes were completed. Flight information is summarized in Appendix Flight #13 and Figure 8.

Data Results

General Data Quality Objective

The following general data quality objectives are employed in conducting emergency response data collection with ASPECT:

1. To support overall situational analysis of the incident including aerial photography and IR imagery
2. To screen the incident for the presence of selected chemicals
3. To estimate the location and concentration of plumes being generated by the incident.

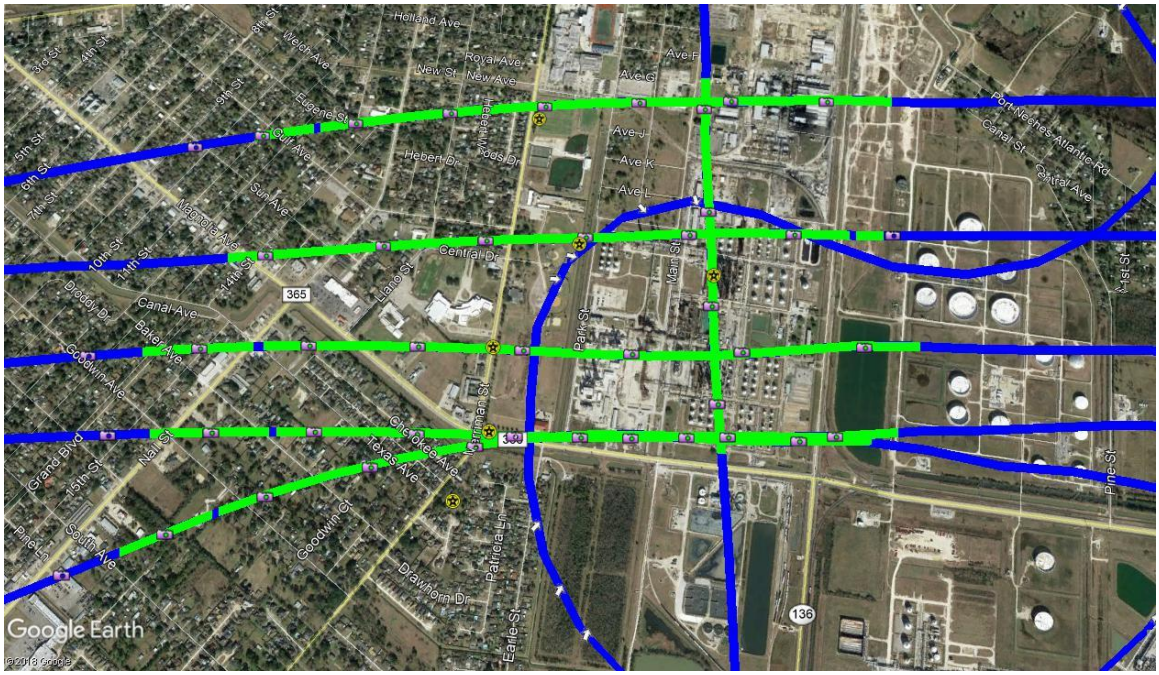

Figure 8: Data collection passes, Flight 13 South 4 Group Fire, Port Neches, TX. The blue lines represent the ASPECT flight path, green lines represent when the FTIR was actively collecting data, the yellow icons with star is the centroid of the line scanner image, and the camera icons represent when a photo was taken.

Line Scanner Data Results

A total of 1 test and 6 data collection passes were made in the proximity of the fire and an infrared line scanner image was generated for each pass. Figure 9 shows a 3-band infrared image obtained from data collected for Run 2. Examination of the image shows no significant elevated thermal locations on this collection pass. No chemical plume was observed in the frame. Figure 10 shows a close-up of the process unit collected on Run 5. No apparent high temperature source is evident in the image.

FTIR Data Results

FTIR Spectral data at a resolution of 16 wavenumbers was collected for each pass. ASPECT uses an automated detection algorithm to permit compounds to be analyzed while the aircraft is in flight. 72 compounds are included in this algorithm and the list is given in Table 5. In addition, collected data are also manually analyzed by comparing any detected spectral signatures to a collection of published library spectra.

Due to reported elevated VOC levels near the community west of the facility, flight lines were extended to provide data collection over these areas approximately 1300 meters west of the facility, detections of 1,3-butadiene and aromatic hydrocarbons were detected. The location of the detection is given in figure 11. Figure 12 show a spectrum for the 1,3-butadiene detection. This is a somewhat complicated spectra since there appears to be other hydrocarbons present in the data. Within the same cluster of detection points, an aromatic such as ethyl benzene was also detected. Figure 13 shows this spectrum with strong peaks just above 700 wave numbers. Analysis of the data shows the highest concentration of 1,3-butadiene at approximately 0.9 ppm. A concentration for the aromatic is difficult since this was analyzed manually but it is estimated that the concentration is less than 1 ppm. A summary of data of the data collection is given in table 6.

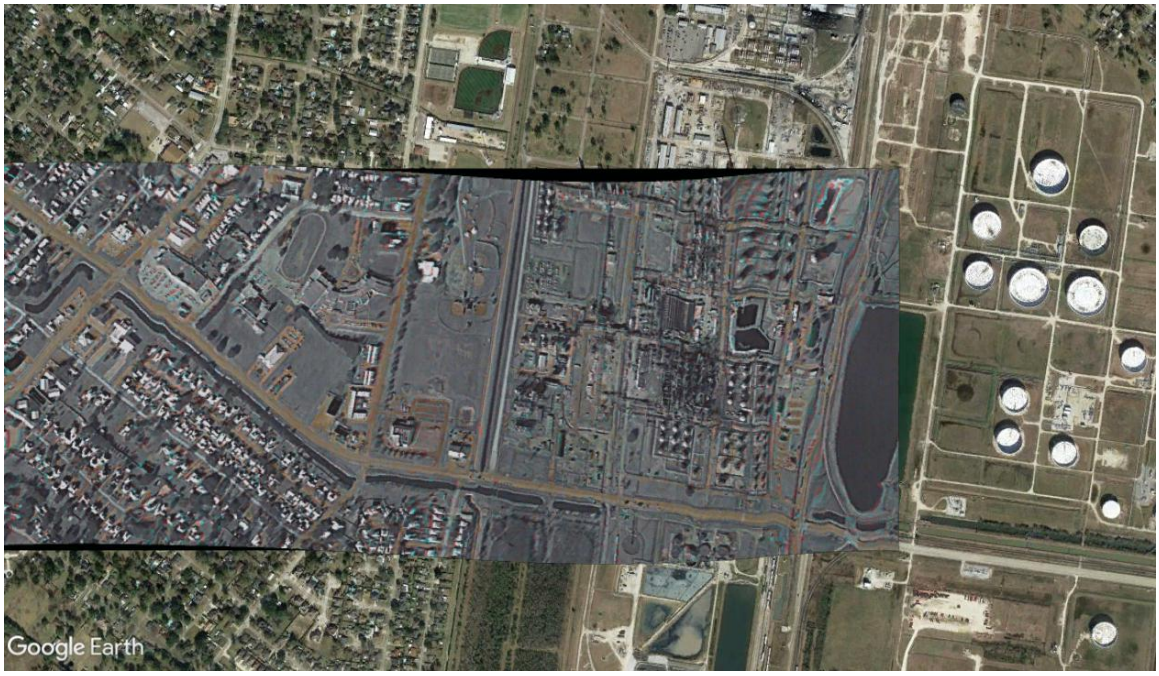

Figure 9: – 3 band IR image, Flight 13, Run 2, South 4 Group Fire

Figure 10: -- 3 band IR image, Flight 13, Run 5, South 4 Group Fire

Figure 11: -- 1,3-Butadiene and Aromatic Hydrocarbon Detection Locations, Flight 13, South 4 Group Fire

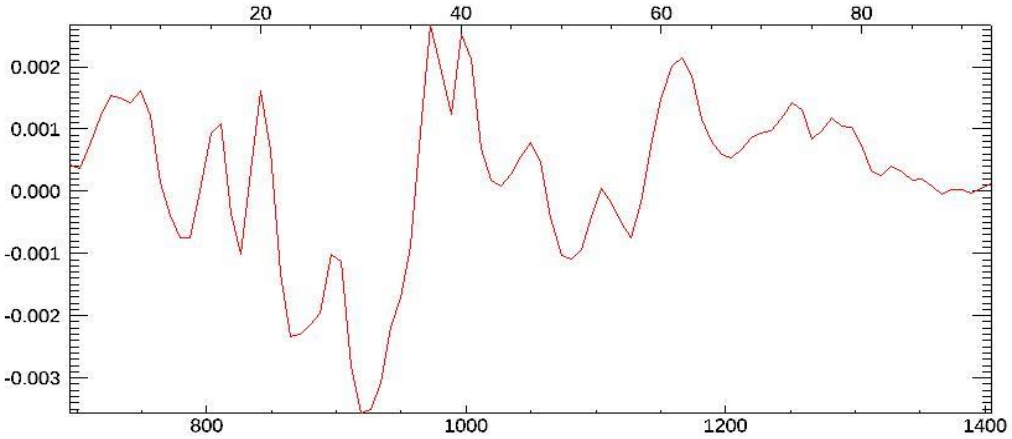

Figure 12: -- 1,3-Butadiene Spectrum, Flight 13, South 4 Group Fire

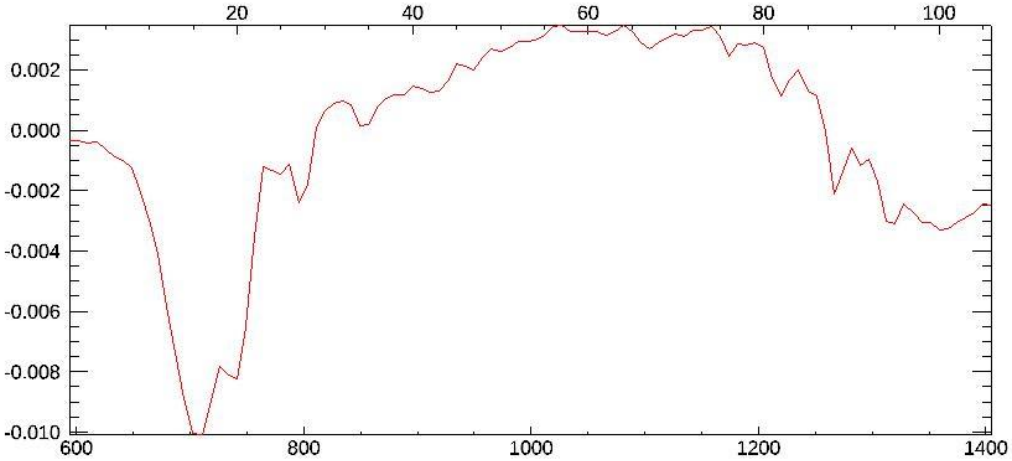

Figure 13: -- Potential Aromatic Spectrum, Flight 13, South 4 Group Fire

TABLE 5 - Chemicals Included in the ASPECT Auto-Processing Library

Acetic Acid	Cumene	Isoprene	Propylene
Acetone	Diborane	Isopropanol	Propylene Oxide
Acrolein	1,1-Dichloroethene	Isopropyl Acetate	Silicon Tetrafluoride
Acrylonitrile	Dichloromethane	MAPP	Sulfur Dioxide
Acrylic Acid	Dichlorodifluoromethane	Methyl Acetate	Sulfur Hexafluoride
Allyl Alcohol	Difluoroethane	Methyl Ethyl Ketone	Sulfur Mustard
Ammonia	Difluoromethane	Methanol	Nitrogen Mustard
Arsine	Ethanol	Methylbromide	Phosgene
Bis-Chloroethyl Ether	Ethyl Acetate	Methylene Chloride	Phosphine
Boron Tribromide	Ethyl Formate	Methyl Methacrylate	Tetrachloroethylene
Boron Triflouride	Ethylene	MTEB	1,1,1-Trichloroethane
1,3-Butadiene	Formic Acid	Naphthalene	Trichloroethylene
1-Butene	Freon 134a	n-Butyl Acetate	Trichloromethane
2-Butene	GA (Tabun)	n-Butyl Alcohol	Triethylamine
Carbon Tetrachloride	GB (Sarin)	Nitric Acid	Triethylphosphate
Carbonyl Chloride	Germane	Nitrogen Trifluoride	Trimethylamine
Carbon Tetraflouride	Hexafluoroacetone	Phosphorus Oxychloride	Trimethyl Phosphite
Chlorodifluoromethane	Isobutylene	Propyl Acetate	Vinyl Acetate

Table 6. Chemical Results Summary

Run	Date	Time (UTC)	Chemical	Max Concentration ppm
1	3 Dec 2019	2027	Test	Test
2		2039	ND	None
3		2043	ND	None
4		2048	ND	None
5		2053	ND	None
6		2058	1,3-Butadiene Aromatic	0.93 < 1
7		2109	ND	None
Note: ND = No Detections				

Aerial Photography Results

A full set of high resolution aerial digital photography were collected as part of the flight. Figure 14 shows a representative image collected as part of each pass. In a similar fashion as the morning flight no smoke was observed being emitted from the site. Oblique imagery does show that water cannons continue to be used to flood the process unit (figure 15).

Conclusions – Flight 13

Two flights conducted on 3 December 2019 indicated that the thermal environment of the unit showed no significant thermal sources. Analysis of images and reports from the crew indicated that no smoke was being generated by the facility. Data collected on the afternoon flight did show the presence of 1,3-butadiene and aromatics 1300 meters west of the facility. Detected levels were approximately 0.93 ppm for 1,3-butadiene and less than 1 ppm for aromatics. IR imagery did not show any oil sheen presence on the Neches River

Figure 14: Aerial Image of the South 4Group Fire, Flight 13

Figure 15: Oblique Image of the South 4Group Fire, Flight 13

Appendix Flight #13

Abbreviations:

DEM – Digital elevation model
Alt – Altitude (in feet)
MSL – Mean sea level altitude (in feet)
Digital – Digital photography file from the Nikon D2X camera
MSIC – Digital photography file from the Imperx mapping camera
FTIR – Spectral IR data collected with a Fourier Transform Infrared Spectrometer
IRLS – Infrared Line Scanner
Jpg – JPEG image format
UTC – Universal Time Coordinated
img – Spectral data format based on Grams format

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Mission:   2019-12-03 South 4 Group Fire

Date:      12/3/2019
Time UTC: 20:20

Aircraft Number: N9738B
Pilot: Todd Seale
Copilot: James Glaviano
Operator: James Crisp
Aft Operator: Gerry Broyles
Ground Controller: Ahmed Hafez

DEM: Using elevation from DEM Database
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Run: 1 Time: 20:27:12 UTC
        Alt: 2797 ft MSL  Elev: 2 ft  Elevation from DEM Database
        Vel: 142 knots  Heading: 280

Digitals:  None
MSIC: 3
        20191203202718205.jpg
        20191203202724570.jpg
        20191203202730919.jpg
FTIR: 1
        20191203_202718_A.igm
IRLS: 1
        2019_12_03_20_27_16_R_01 TA=17.0;TB=36.7;Gain=3
Gamma Runs:  None

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Run: 2 Time: 20:39:14 UTC
        Alt: 2809 ft MSL Elev: 9 ft Elevation from DEM Database
        Vel: 110 knots Heading: 266

Digitals: None
MSIC: 8
        20191203203919987.jpg
        20191203203927241.jpg
        20191203203933605.jpg
        20191203203939954.jpg
        20191203203946304.jpg
        20191203203952668.jpg
        20191203203959017.jpg
        20191203204005382.jpg
FTIR: 2
        20191203_203917_A.igm
        20191203_203957_A.igm
IRLS: 1
        2019_12_03_20_39_18_R_02 TA=17.0;TB=37.0;Gain=3
Gamma Runs: None

Run: 3 Time: 20:43:56 UTC
        Alt: 2720 ft MSL Elev: 10 ft Elevation from DEM Database
        Vel: 106 knots Heading: 92

Digitals: None
MSIC: 7
        20191203204402343.jpg
        20191203204409597.jpg
        20191203204415962.jpg
        20191203204422311.jpg
        20191203204428660.jpg
        20191203204435025.jpg
        20191203204441374.jpg
FTIR: 2
        20191203_204400_A.igm
        20191203_204439_A.igm
IRLS: 1
        2019_12_03_20_44_01_R_03 TA=14.4;TB=34.6;Gain=3
Gamma Runs: None

Run: 4 Time: 20:48:25 UTC
        Alt: 2787 ft MSL Elev: 10 ft Elevation from DEM Database
        Vel: 102 knots Heading: 260

Digitals: None
MSIC: 8
        20191203204831987.jpg
        20191203204838336.jpg
        20191203204844685.jpg

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        20191203204851050.jpg
        20191203204857399.jpg
        20191203204903763.jpg
        20191203204910113.jpg
        20191203204914652.jpg
FTIR: 2
        20191203_204828_A.igm
        20191203_204907_A.igm
IRLS: 1
        2019_12_03_20_48_29_R_04 TA=14.4;TB=34.5;Gain=3
Gamma Runs:  None

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Run: 5 Time: 20:53:50 UTC
        Alt: 2752 ft MSL  Elev: 8 ft  Elevation from DEM Database
        Vel: 103 knots  Heading: 182

Digitals:  None
MSIC: 4
        20191203205356104.jpg
        20191203205403358.jpg
        20191203205409722.jpg
        20191203205416071.jpg
FTIR: 1
        20191203_205354_A.igm
IRLS: 1
        2019_12_03_20_53_54_R_05 TA=14.3;TB=34.3;Gain=3
Gamma Runs:  None

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Run: 6 Time: 20:58:11 UTC
        Alt: 2754 ft MSL  Elev: 8 ft  Elevation from DEM Database
        Vel: 102 knots  Heading: 264

Digitals:  None
MSIC: 8
        20191203205817573.jpg
        20191203205823922.jpg
        20191203205830287.jpg
        20191203205837541.jpg
        20191203205843906.jpg
        20191203205850255.jpg
        20191203205856620.jpg
        20191203205902969.jpg
FTIR: 2
        20191203_205815_A.igm
        20191203_205853_A.igm
IRLS: 1
        2019_12_03_20_58_16_R_06 TA=14.5;TB=34.5;Gain=3
Gamma Runs:  None

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Run: 7 Time: 21:09:29 UTC
        Alt: 2739 ft MSL Elev: 8 ft Elevation from DEM Database
        Vel: 106 knots Heading: 254

Digitals: None
MSIC: 8
        20191203210935773.jpg
        20191203210942122.jpg
        20191203210948487.jpg
        20191203210954836.jpg
        20191203211001201.jpg
        20191203211007550.jpg
        20191203211013915.jpg
        20191203211020264.jpg
FTIR: 2
        20191203_210932_A.igm
        20191203_211011_A.igm
IRLS: 1
        2019_12_03_21_09_34_R_07 TA=13.7;TB=33.7;Gain=3
Gamma Runs: None

Run: 8 Time: 21:25:16 UTC
        Alt: 2813 ft MSL Elev: 0 ft Elevation from DEM Database
        Vel: 102 knots Heading: 266

Digitals: None
MSIC: 5
        20191203212522712.jpg
        20191203212529076.jpg
        20191203212535426.jpg
        20191203212541775.jpg
        20191203212543600.jpg
FTIR: 1
        20191203_212520_A.igm
IRLS: 1
        2019_12_03_21_25_21_R_08 TA=12.8;TB=32.8;Gain=3
Gamma Runs: None

Run: 9 Time: 21:31:49 UTC
        Alt: 2786 ft MSL Elev: 0 ft Elevation from DEM Database
        Vel: 107 knots Heading: 91

Digitals: None
MSIC: 4
        20191203213155834.jpg
        20191203213202194.jpg
        20191203213208542.jpg
        20191203213214892.jpg
FTIR: 1

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        20191203_213152_A.igm
IRLS: 1
        2019_12_03_21_31_54_R_09 TA=12.8;TB=32.8;Gain=3
Gamma Runs:  None

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Run: 10 Time: 21:36:06 UTC
        Alt: 2798 ft MSL  Elev: 0 ft  Elevation from DEM Database
        Vel: 110 knots  Heading: 266

Digitals:  None
MSIC: 4
        20191203213612775.jpg
        20191203213619124.jpg
        20191203213625473.jpg
        20191203213631839.jpg
FTIR: 1
        20191203_213610_A.igm
IRLS: 1
        2019_12_03_21_36_10_R_10 TA=11.5;TB=31.5;Gain=3
Gamma Runs:  None

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Run: 11 Time: 21:41:26 UTC
        Alt: 2888 ft MSL  Elev: 0 ft  Elevation from DEM Database
        Vel: 110 knots  Heading: 183

Digitals:  None
MSIC: 4
        20191203214132356.jpg
        20191203214139610.jpg
        20191203214145974.jpg
        20191203214152324.jpg
FTIR: 1
        20191203_214129_A.igm
IRLS: 1
        2019_12_03_21_41_31_R_11 TA=11.0;TB=31.0;Gain=3
Gamma Runs:  None

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Run: 12 Time: 21:46:13 UTC
        Alt: 2763 ft MSL  Elev: 0 ft  Elevation from DEM Database
        Vel: 106 knots  Heading: 265

Digitals:  None
MSIC: 4
        20191203214620158.jpg
        20191203214626508.jpg
        20191203214632872.jpg
        20191203214639222.jpg
FTIR: 1
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20191203_214618_A.igm
IRLS: 1
2019_12_03_21_46_18_R_12 TA=11.0;TB=31.0;Gain=3
Gamma Runs: None